

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

EET2066 – POWER TECHNOLOGY
(RE)

14 MARCH 2020
2:30pm – 4:30pm
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 3 pages excluding cover page with 4 Questions only.
2. Attempt **ALL (4)** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1 [25 marks]

- (a) Briefly describe **THREE (3)** classifications of power semiconductor devices based on degree of controllability in the power circuit. Provide an example for each category. [6 marks]
- (b) Figure Q1(b) shows a series connection of two power diodes. Discuss the limitations of this circuit and hence propose a solution to overcome the problems. [6 marks]

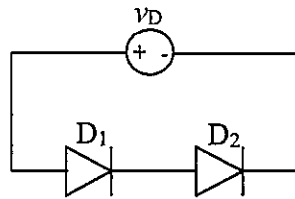


Figure Q1(b)

- (c) Figure Q1(c) shows the switching waveforms of a power BJT terminated with resistive load. The transistor operates at 40% duty cycle with $\tau_{on} = \tau_{off} = 2\mu s$, $\beta = 100$ and $V_{BE(on)} = 0.7 V$. Calculate the power loss dissipation occurred in the switch. [13 marks]

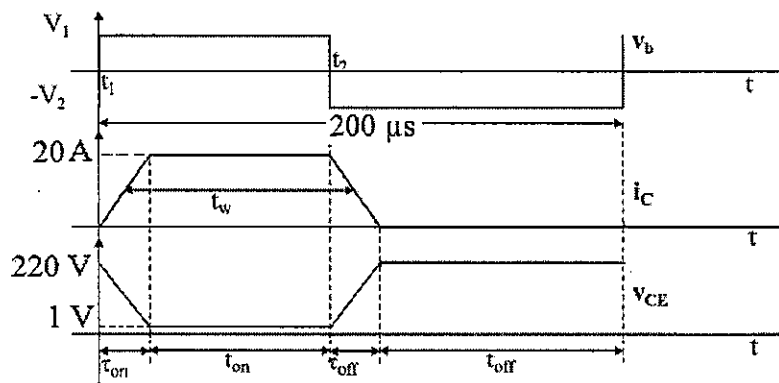


Figure Q1(c)

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Question 2 [25 marks]

- (a) Briefly describe for the following terms:
- (i) Commutation [2 marks]
 - (ii) Line commutation [2 marks]
 - (iii) Forced commutation [2 marks]

- (b) Figure Q2(b) shows a single phase half wave rectifier with resistive load.

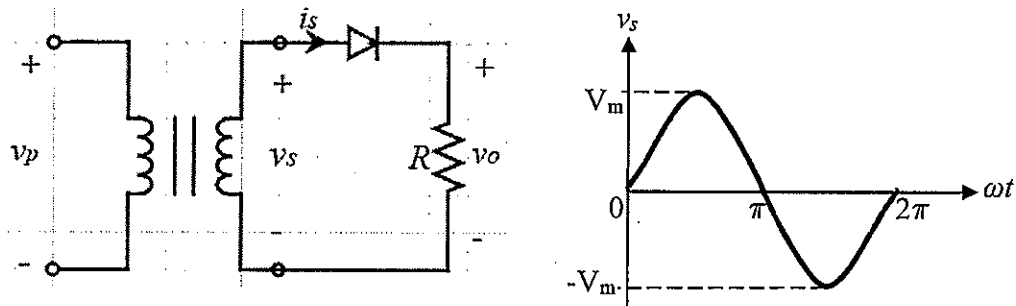


Figure Q2(b)

- (i) Derive and show that average output voltage is expressed as $V_{ave} = 0.318V_m$. Hence, determine the average output current expression (I_{ave}). [5 marks]
- (ii) Derive and show that RMS output voltage is expressed as $V_{rms} = 0.5V_m$. Hence, determine the RMS output current expression (I_{rms}). [5 marks]
- (iii) Determine the efficiency of this rectifier. [3 marks]
- (iv) Sketch the one complete cycle for following waveforms:
 - 1. Output voltage (v_o) [2 marks]
 - 2. Diode voltage (v_D) [2 marks]
 - 3. Output current (i_s) [2 marks]

Continued...

Question 3 [25 marks]

A boost converter operates at 250Hz under continuous conduction mode has $25\ \Omega$ load resistance, 150 V input voltage and 12 A average load current. Calculate the load inductance such that maximum load ripple current is limited to 10% of I_L .

- (a) Sketch the circuit diagram for this converter. [3 marks]
- (b) Calculate the value for output voltage and duty cycle. [4 marks]
- (c) Determine the inductance value and current ratings of the inductor. [7 marks]
- (d) Derive the equation for ripple factor. Hence calculate the capacitance value such that the ripple at output voltage is less than 1.5%. [6 marks]
- (e) Draw the inductor current and inductor voltage waveforms. Clearly indicate all numerical values at the waveforms. [5 marks]

Question 4 [25 marks]

- (a) Discuss **FOUR (4)** categories of inverters based on the types of AC output. [8 marks]
- (b) A full bridge inverter with 120 V voltage source operating at 1.5k Hz with 60% duty cycle is connected to RL load with $R=20\ \Omega$ and $L=2\text{mH}$. The Fourier Series expression for the instantaneous output voltage is given as:

$$v(\omega t) = \sum_{n=1,3,5,\dots}^{\infty} \frac{4V_s}{n\pi} \sin \frac{nD\pi}{2} \cos n \left(\omega t - \frac{D\pi}{2} \right)$$

- (i) Write the voltage expression for fundamental frequency component. [1 mark]
- (ii) Determine for the following parameters:
 - 1. RMS value of fundamental component ($V_{1,\text{rms}}$). [2 marks]
 - 2. RMS value of total harmonic components ($V_{H,\text{rms}}$). [4 marks]
 - 3. Voltage transfer ratio (T_{vv}). [2 marks]
 - 4. Total harmonic distortion (THD). [3 marks]
- (iii) Calculate the duty cycle value such that 3rd harmonics component is eliminated. [3 marks]
- (iv) Draw the output voltage waveform for one complete cycle. [2 marks]

End of page.